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CALSPAN ADVANCED TECHNOLOGY CENTER

APPLICATIONS OF HCMH SATELLITE DATA

Contract No. NAS5-24263

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DATA Quarterly Report, 23 May - 23 Aug.
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Twelfth Quarterly Report

5/23/80 - 8/23/80

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Objectives:

The objectives of this investigation are to study the thermal properties of Great Lakes, Erie and Ontario, as they relate to water quality, lake hydrology and energy exchange; to study the urban heat island problem in selected areas adjacent to these lakes; and to refine techniques required to obtain accurate surface radiometric temperatures.

Problems:

. No significant problems this reporting period.

Accomplishments:

Efforts this reporting period have been directed in all three major program directions and considerable advances were made in each area.

Satellite Sensor Calibration

The May 22, 1978 underflight data were radiometrically calibrated at several locations and surface water temperature measurements were made for several areas approximating the field of view of the HCMM sensor. The temperatures obtained from the radiometrically corrected imagery were then plotted against the apparent temperatures for these same locations obtained from the HCMM CCT's. Figure 1 contains an example of the values obtained near nine mile point on Lake Ontario. Figure 2 is a plot of the least squares fit between the surface and satellite observation for two areas approximately 100 miles apart. These results indicate the corrections needed for the satellite data at specific locations and will provide some of the input for development of a more generalized model for radiometric correction of HCMM data.

Thermal Bar Studies

The sensor calibration model described above will be used to correct HCMM data to provide detailed maps of thermal bar development in Lake Ontario. Figure 3 shows an uncorrected map of the observed isotherms generated from a HCMM CCT. Once the point corrections described above are finalized and limb functions incorporated for whole scene correction, actual surface temperature maps of the entire lake can be generated.

During the reporting period, Landsat CCT's covering portions of Lake Ontario for two dates during the thermal bar were received. The tapes contain data for all 4 MSS bands, and can provide information on water quality associated with the thermal bar. The two tapes are described in the updated project listing of CCT's provided herein as Table 1.

Canada Centre for Inland Waters (CCIW) provided a provisional listing of Lake Ontario data from its Great Lakes water quality monitoring program. The listing consists of data from 93 monitoring stations taken during the period May 8-12, 1978 and from 94 stations during June 5-9. A sample page for one of the monitoring stations is provided as Table 2. These supplementary data sources will be used to evaluate the effects of the thermal bar on water quality and the potential for satellite observation of the phenomena.

Landsat derived water quality signatures, particularly in large lakes, are often masked by variations in the intervening atmosphere. Initial investigations into monitoring and accounting for variations in the atmosphere across a portion of a Landsat image have been undertaken. The correlation of atmospheric effects between individual wavelengths is being investigated using Landsat coverage of Lake Ontario. The area chosen contains stratus clouds of varying density which permit the correlations to be developed.

Examination of the exposure levels within bands 4, 5, and 7 indicate that the effects of variable cloud cover on the three bands is linearly correlated as shown in Figure 4. Therefore, if the atmospheric effects due to cloud cover or haze can be identified in one band, the corresponding effects in the other bands can be predicted. Since turbidity has only a small effect on the infrared reflectance of water, water is characterized by a relatively constant reflectance level within band 7 imagery. Variations in the atmospheric component of exposure over water bodies can therefore be monitored easily within this band. Atmospheric effects can then be predicted for bands 4 and 5 and removed pixel by pixel based on the information obtained from band 7. Once the variable atmospheric effects have been removed from the band 4 and band 5 imagery, the variations in exposure due to water quality (visible in bands 4 and 5) can be determined.

Heat Island Phenomena

Thermal patterns of several urban areas have been generated from HCMM tapes and scaled to corresponding land use and topographic maps. The resulting map overlays are being interpreted in terms of land use influence on the extent and severity of heat island indicators.

Significant Results

HCMH derived data were successfully cross-calibrated using under-flight data. The sensor calibration model provides a foundation for development of a refined model for radiometric correction of HCMH data.

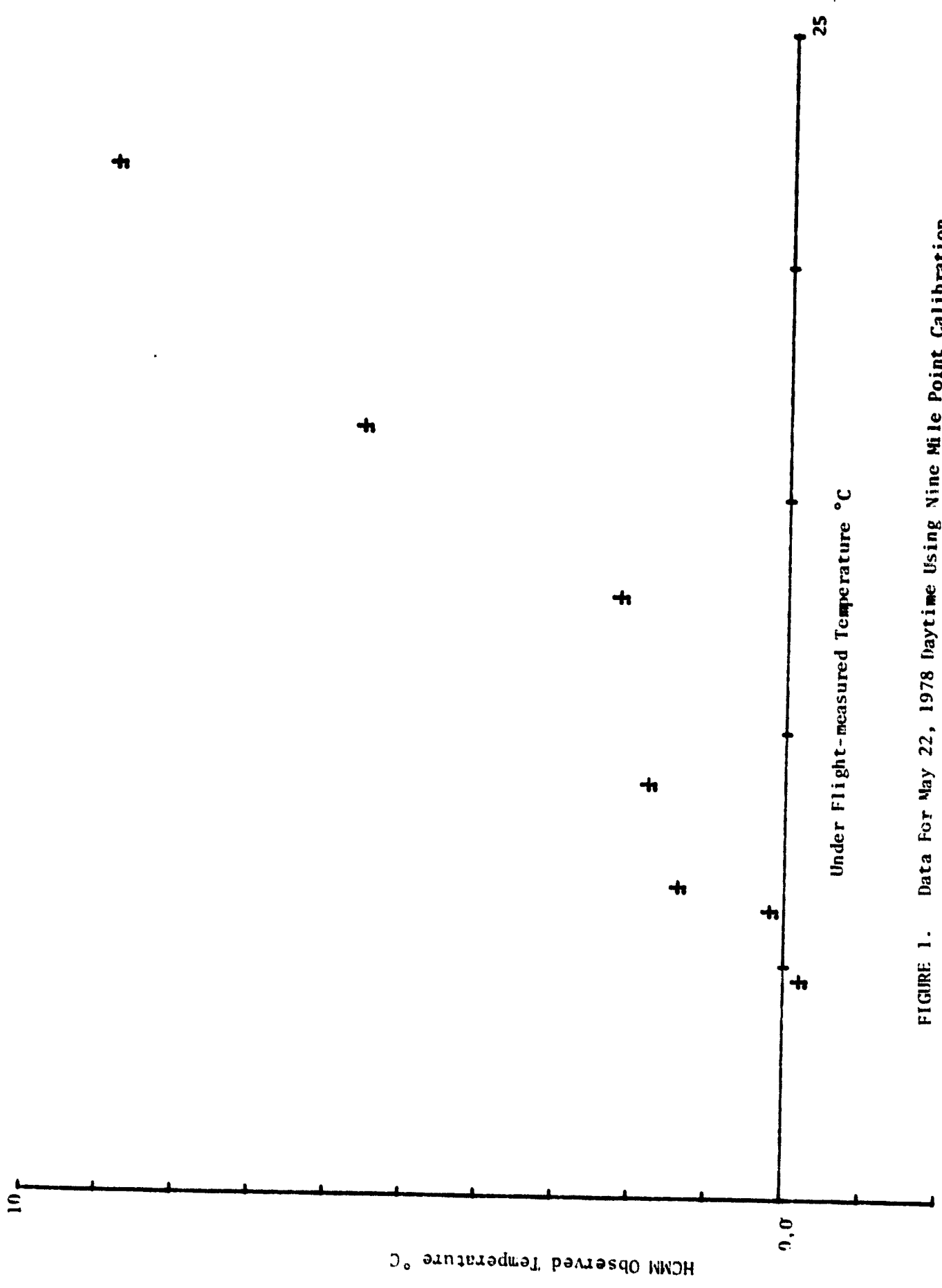


FIGURE 1. Data For May 22, 1978 Daytime Using Nine Mile Point Calibration

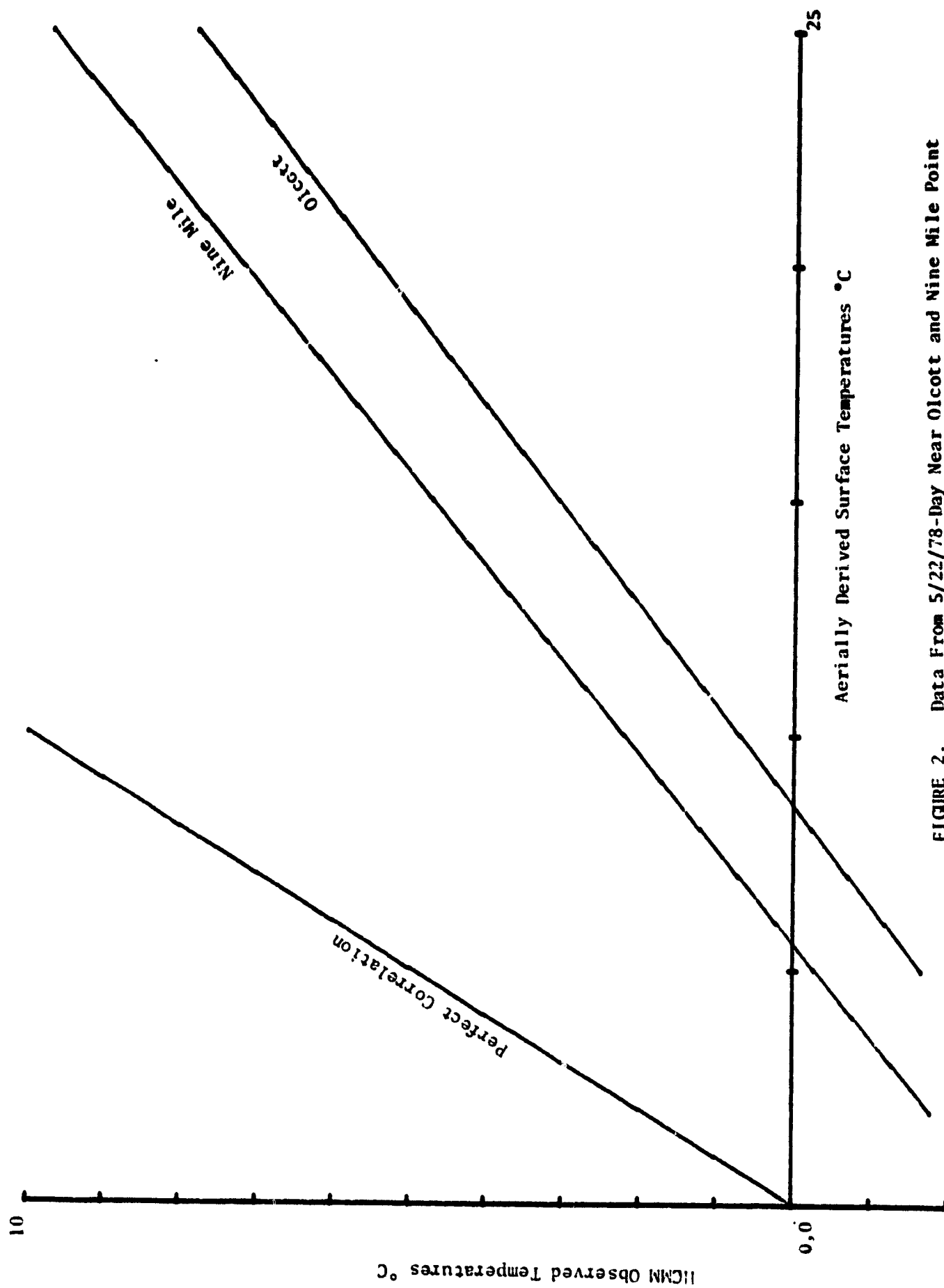


FIGURE 2. Data From 5/22/78-Day Near Olcott and Nine Mile Point

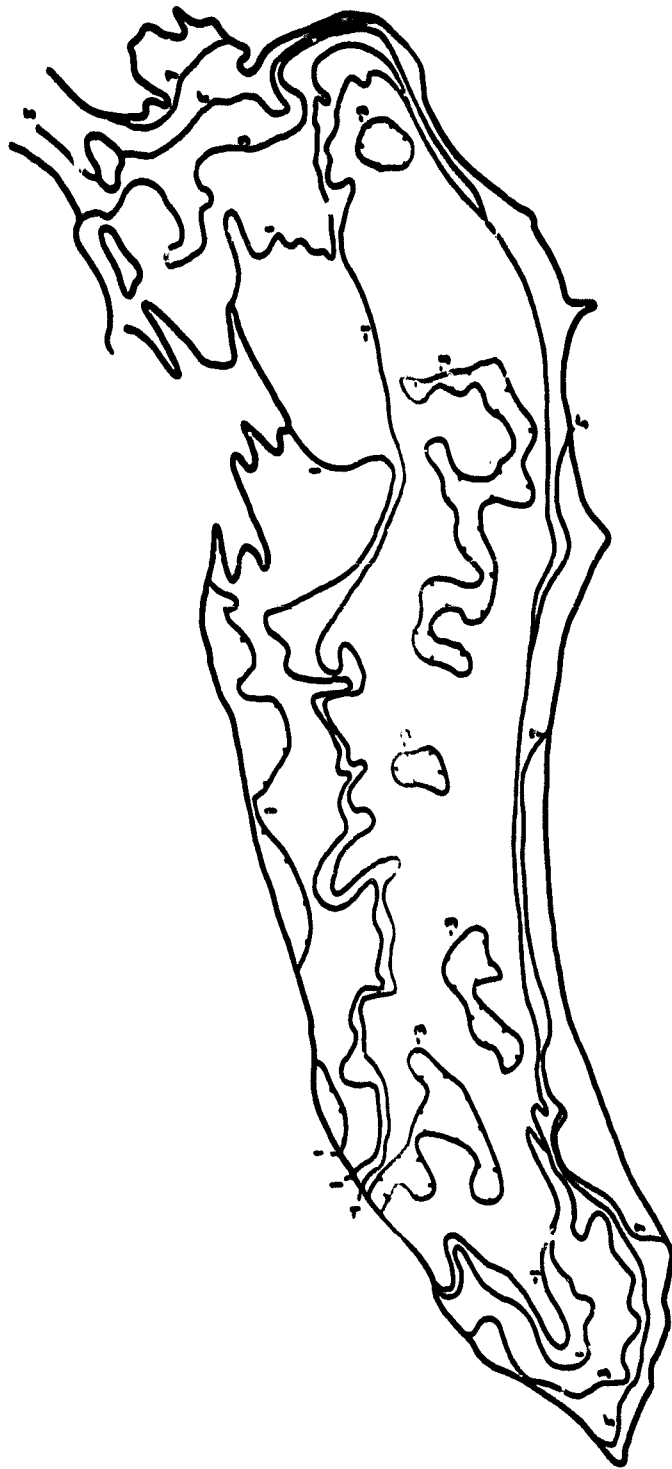


FIGURE 3

Apparent Radiometric Temperature ($^{\circ}\text{C}$)
Lake Ontario - 6 June 1978
243 Night IR

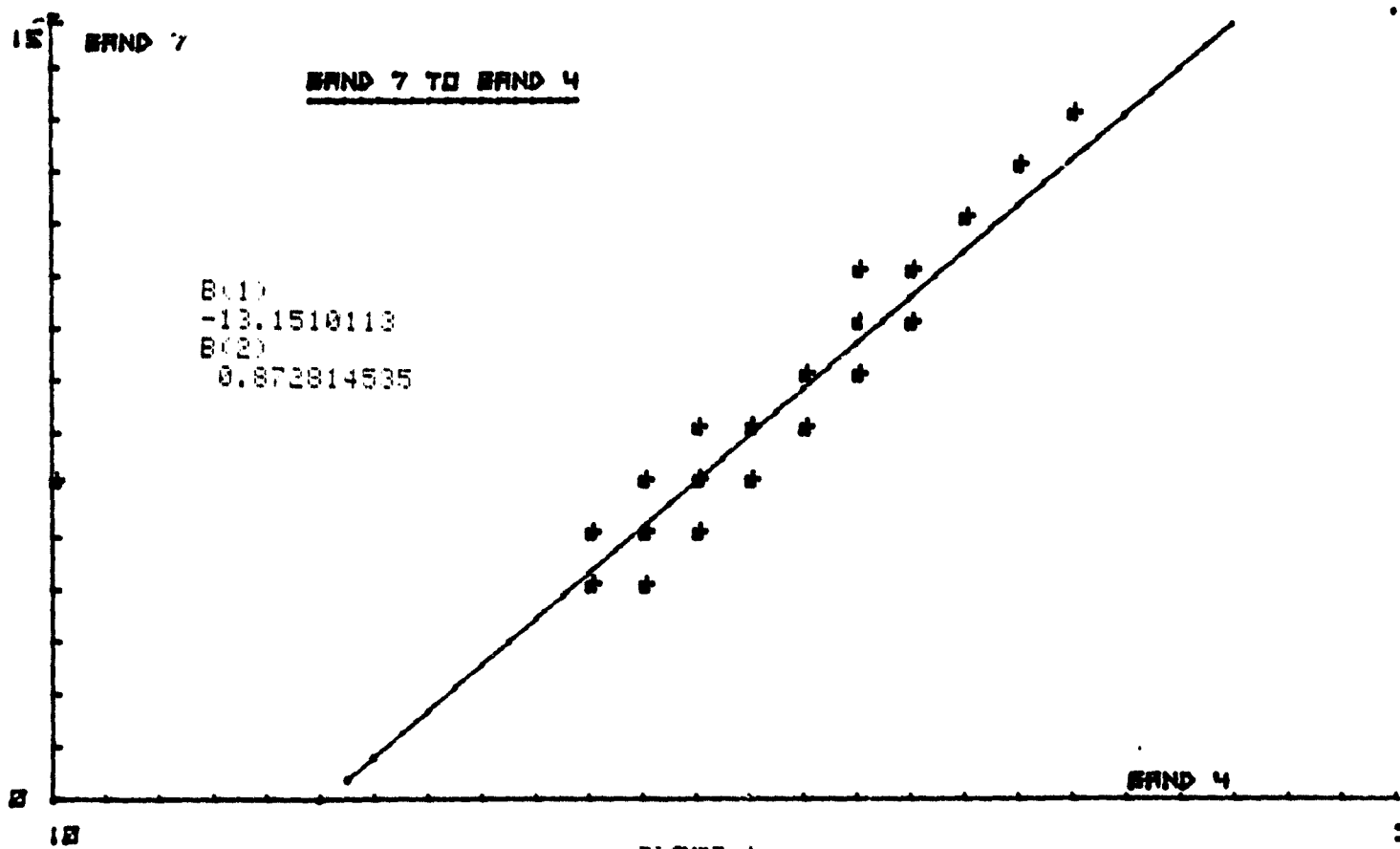
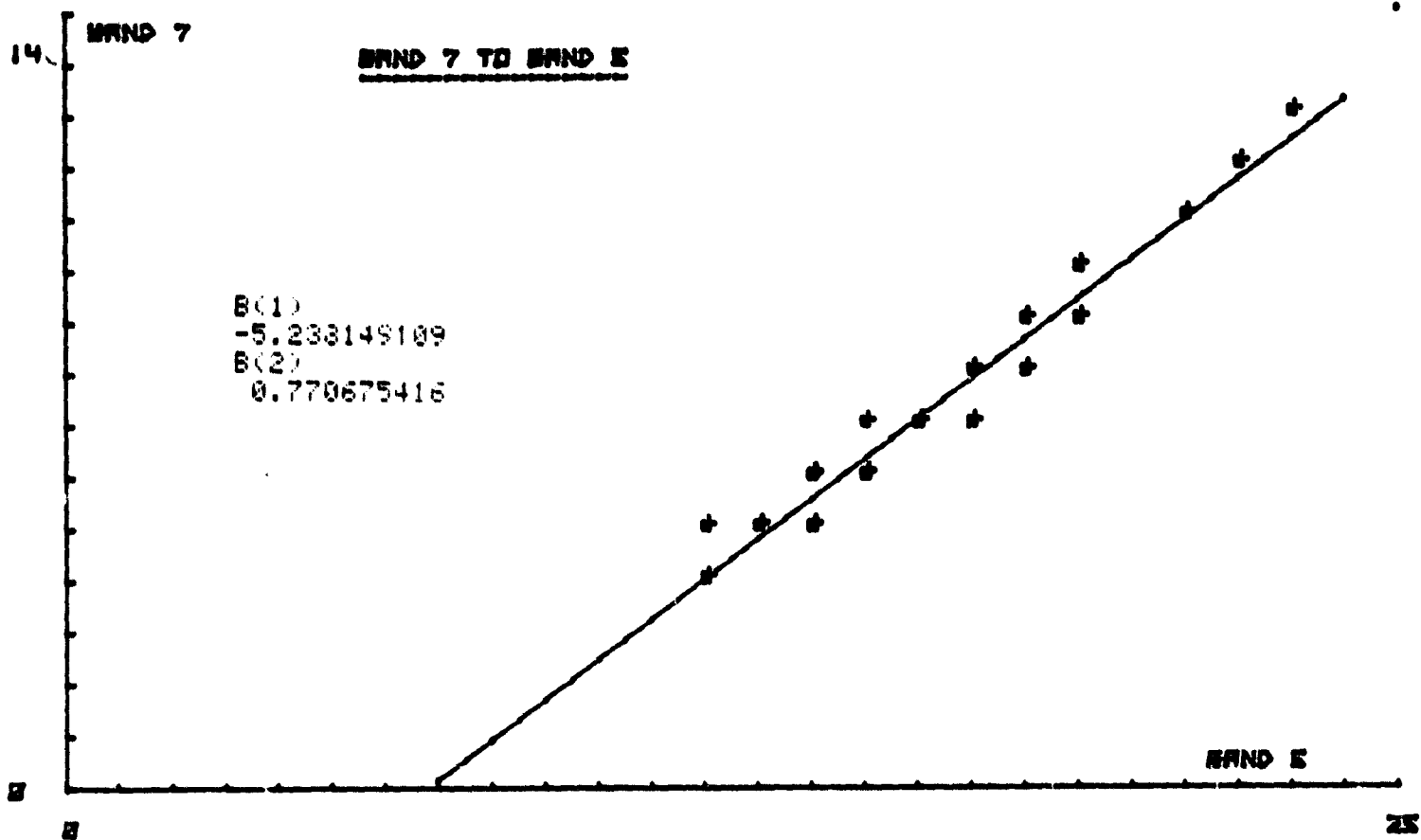


FIGURE 4

TABLE 1

LISTING OF CUTS FOR HEAT CAPACITY TAPPING MISSION (HCOM) PROGRAM (Includes Registered Tapes)

Tape Inventory Control No.	Scene Idem. No.	Imagery Description	Targets Covered
<u>IRCON Tapes</u>			
RP 6912H	AA0026 18490-1 " " -2	22 May '78 Day/VIS (027) " " Day/IR (028)	Buffalo, Rochester, Syracuse, L. Ontario
	AA0026 18500-1 " " -2	22 May '78 Day/VIS (025) " " Day/IR (026)	Lake Ontario
RS 0478A	AA0026 18490-1 " " -2	22 May '78 Day/VIS (030) " " Day/IR (039)	All Targets Clear (some probably reformated from RP 6912H to include all targets in one scene - recommend checking tape lead coordinates to confirm this)
RS 6260G	AA0190 18020-1 " " -2	2 Nov. '78 Day/VIS (003) " " Day/IR (004)	Rochester, Syracuse, E. 2/3 L. Ontario
RU 8303I	AA0110 18140-1 " " -2	14 Aug. '78 Day/VIS (105) " " Day/IR (106)	Rochester, Syracuse, L. Ontario
RP 6118E	AA0041 07360-3	6 June '78 Night/IR (243)	All Targets Clear (some apparently requires two tapes - see RP 2011K)
PM 2011K	AA0041 07360-3	6 June '78 Night/IR (243)	All Targets Clear (some apparently requires two tapes - see RP 6118E)
QL 5109F	AA0041 18310-1	6 June '78 Day/VIS (011)	All Targets Clear (transparency shows interference line running through Rochester and southern shore of Lake Ontario near Rochester)
RT 1628A	AA0041 18310-2	6 June '78 Day/IR (012)	All Targets Clear
CL 0769H	AA0078 07250-3	13 July '78 Night/IR (024)	All Targets Clear
RW 4963C	AA0153 07200-3	26 September '78 Night/IR	All Targets Clear (recommend checking tape lead to verify description)
SD 1909B	AA0153 18160-1	26 September '78 Day/VIS (050)	All Targets Clear
	AA0153 18160-2	26 September '78 Day/IR (051)	All Targets Clear
	AA0153 07160-6	26 September '78 Day/VIS Elongated	All Targets Clear
SD 1915F	AA0153 07160-7	26 September '78 Day/IR Elongated	All Targets Clear
SD 1547K	AA0153 07160-8	26 September '78 Night/IR Elongated	All Targets Clear
<u>Landsat Tapes</u>			
	83010115175X0	14 June '78 Path 18 Row 36	Buff., Roch., L. Ont. from Niagara-on-the-Lake to Sodus Bay - very clear. Close to June 6th underflight.
	83008215120X0	26 May '78 Path 17 Row 30	Roch., Syr., Finger Lakes, L. Ont. from Braddock Bay to Sandy Pond. Close to May 22nd underflight.

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 2

DATE ACCESSFD 27/06/80

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CCIW WATER QUALITY MONITORING PROGRAM

CRUISE NUMBER 78-22-007

LAKE ONTARIO

VESSEL NAME LIMNOS

STARTING DATE 05/06/1978

C-REF-11C 007
 CONS. NO 049
 COUNTRY 18
 INSTITUTE 22
 AIR TEMP 13.2

LAT 43-41-54N
 LON 076-24-50W
 WIND DIR 135
 WIND SP 14 KT

YEAR 1978
 MONTH 06
 DAY 07
 TIME 1642

NO. DEPTHS 6
 SOUNDING 22.0
 BT TYPE ELEC
 PERM. STA. NO. 089

BATHYTHERMOGRAPHY:

DEPTH 0.0 5.0 9.0 14.0 19.0 24.0
 TEMP. 4.2 4.2 4.1 4.0 3.9 3.8

DEPTH	SECCHI	FORCL-JL	TEMP	T EST	TRANS	SP-CON	PH
0.0	5.0	9.0	4.30				
1.0	---	---	---	4.22	6.83.	334.	8.19
2.0	---	---	---	4.21	---	340.	8.21
3.0	---	---	---	4.10	---	333.	8.15
4.0	---	---	---	3.74	---	334.	8.13

DEPTH	PH TEMP	F ALK033	U CRG C	O-O2-W	SAT O2	T P	SR F
0.0	---	---	---	---	---	---	---
1.0	5.8	43.0	1.9	13.71	106.	0.170	0.0032
2.0	5.3	43.0	1.9	13.36	103.	0.170	0.0034
3.0	5.4	43.0	1.9	13.34	103.	0.173	0.0031
4.0	5.1	44.0	1.9	13.15	100.	0.160	0.0033

DEPTH	T P	NO3	NO3NO2 F	TP N	SO4 F	CL F	# S102
0.0	---	---	---	---	---	---	---
1.0	0.110	0.002	0.322	0.440	24.9	27.6	0.422
2.0	0.110	0.002	0.325	0.430	24.9	27.6	0.425
3.0	0.110	0.001	0.324	0.440	24.9	27.5	0.424
4.0	0.110	0.002	0.325	0.440	24.9	27.6	0.426

DEPTH	CA FA	MG F	X FS	NA FS	CAUI	CACI
0.0	---	---	---	---	---	---
1.0	39.5	4.1	1.5	13.3	---	---
2.0	40.0	4.1	1.5	12.9	---	---
3.0	40.0	4.1	1.5	13.0	2.0	1.5
4.0	40.0	4.1	1.5	13.0	---	---